



Chu, C. J., Johnston, R. L., Buscombe, C., Sallam, A. B., Mohamed, Q., Yang, Y. C. (2016). Risk Factors and Incidence of Macular Edema after Cataract Surgery: A Database Study of 81984 Eyes. *Ophthalmology*, 123(2), 316-323.  
<https://doi.org/10.1016/j.opththa.2015.10.001>

Publisher's PDF, also known as Version of record

License (if available):  
CC BY-NC-ND

Link to published version (if available):  
[10.1016/j.opththa.2015.10.001](https://doi.org/10.1016/j.opththa.2015.10.001)

[Link to publication record in Explore Bristol Research](#)  
PDF-document

This is the final published version of the article (version of record). It first appeared online via Elsevier at <http://www.sciencedirect.com/science/article/pii/S016164201501146X>. Please refer to any applicable terms of use of the publisher.

## University of Bristol - Explore Bristol Research

### General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available:  
<http://www.bristol.ac.uk/red/research-policy/pure/user-guides/ebr-terms/>

# Risk Factors and Incidence of Macular Edema after Cataract Surgery

## A Database Study of 81 984 Eyes

Colin J. Chu, PhD,<sup>1</sup> Robert L. Johnston, FRCOphth,<sup>2</sup> Charlotte Buscombe, MRCP,<sup>2</sup> Ahmed B. Sallam, FRCOphth,<sup>2,3</sup> Queresh Mohamed, FRCOphth,<sup>2</sup> Yit C. Yang, FRCOphth,<sup>4,5</sup> for the United Kingdom Pseudophakic Macular Edema Study Group\*

**Purpose:** To define the incidence of pseudophakic macular edema (PME) after cataract surgery and to identify contributory risk factors.

**Design:** Retrospective database study of electronic medical records (EMRs).

**Participants:** A total of 81 984 eyes undergoing cataract surgery between December 2010 and December 2014 from 8 independent United Kingdom clinical sites.

**Methods:** Structured clinical data mandated by the EMR were anonymized and extracted for each eye undergoing cataract surgery including: perioperative visual acuity, copathologic features, simultaneous surgical procedures, and the presence or absence of a specified list of intraoperative complications. Diabetic status with matched Early Treatment Diabetic Retinopathy Study (ETDRS) grading also was mandated by the EMR. Eyes receiving prophylactic nonsteroidal anti-inflammatory drugs were excluded.

**Main Outcome Measure:** Diagnosis of cystoid macular edema or new-onset macular edema in patients with diabetes, recorded by a healthcare professional within 90 days of surgery.

**Results:** Baseline incidence of PME in eyes without operative complications, diabetes, or risk factors was 1.17%. Eyes in which PME developed were more likely to be male, older, and to demonstrate risk factors. The relative risk (RR) was increased in eyes with capsule rupture with or without vitreous loss (RR, 2.61; 95% confidence interval [CI], 1.57–4.34), a previous diagnosis of epiretinal membrane (RR, 5.60; 95% CI, 3.45–9.07), uveitis (RR, 2.88; 95% CI, 1.50–5.51), retinal vein occlusion (RR, 4.47; 95% CI, 2.56–5.92), or retinal detachment repair (RR, 3.93; 95% CI, 2.60–5.92). High myopia, age-related macular degeneration, or prostaglandin analog use were not shown to increase risk. Eyes with PME on average had poorer postoperative visual acuity, which persisted to the latest time point assessed, up to 24 weeks. Eyes from patients with diabetes, even in the absence of retinopathy, had an increased RR (RR, 1.80; 95% CI, 1.36–2.36) of new macular edema after surgery. The risk was higher in the presence of any diabetic retinopathy (DR; RR, 6.23; 95% CI, 5.12–7.58) and rose proportionately with increasing severity of DR.

**Conclusions:** Pseudophakic macular edema occurs commonly after phacoemulsification cataract surgery, even in the absence of complications and risk factors. This large retrospective study using structured EMR data quantified the RRs of PME and the risk with increasing ETDRS severity of DR. It highlights the need for prophylactic therapy, especially in those groups of eyes with the highest RRs. *Ophthalmology* 2016;123:316–323 © 2016 by the American Academy of Ophthalmology. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).



\*Supplemental material is available at [www.aaojournal.org](http://www.aaojournal.org).

Cataract is the leading global cause of blindness, and cataract surgery is one of the most common operations performed worldwide.<sup>1</sup> Pseudophakic macular edema (PME), which typically is cystoid, remains the most frequent postoperative complication to result in impaired vision.<sup>2,3</sup> The incidence of PME in previous studies varies between 0.2% to 20%,<sup>4</sup> depending on whether the diagnosis was confirmed by clinical examination alone or with optical coherence tomography (OCT) or fluorescein angiography. With the advent of modern phacoemulsification techniques, the more

recently reported rates of PME seem to be much lower, between 0.2% and 2.35%.<sup>5,6</sup> However, some groups of patients, such as those with diabetes, who have the highest risk of new postoperative edema developing and the greatest challenges in terms of prophylaxis and treatment, tend to have been excluded from previous studies of postoperative PME.<sup>7,8</sup>

Given recent evidence of the potential benefits of new topical nonsteroidal anti-inflammatory drugs (NSAIDs) and of various intravitreal corticosteroid and anti-vascular

endothelial growth factor agents for the prophylaxis and treatment of postoperative edema in patients with and without diabetes, this study re-evaluated the current incidence of postoperative PME in a real-world clinical practice setting.<sup>2,3</sup> The United Kingdom National Health Service provides an ideal study environment because it serves more than 90% of the population for cataract surgery, and there has been widespread adoption of electronic medical record (EMR) systems that mandate collection of detailed datasets developed by The Royal College of Ophthalmologists.<sup>7,8</sup> In this multicenter study, we investigated the incidence of postoperative PME and its impact on postoperative visual acuity, and quantified the effect of various known or suspected risk factors in a large consecutive cohort of patients, including those with diabetes, who were undergoing cataract surgery in a real-world clinical setting.

## Methods

Eight National Health Service hospital ophthalmology departments in the United Kingdom that use the same EMR system (Medisoft Ophthalmology; Medisoft Limited, Leeds, United Kingdom) for the routine capture of clinical data on patients, based on nationally agreed-on standardized datasets for cataract and diabetic eye disease care pathways developed by the Royal College of Ophthalmologists,<sup>9,10</sup> were invited to participate in the study. The structured assessment of diabetic retinopathy (DR) within the EMR, when completed, forces the recording of the minimum signs necessary for an algorithm within the software to calculate a precise ETDRS grading of retinopathy and maculopathy.

All sites had large ophthalmology departments with a representative case mix of patients undergoing day-case cataract surgery performed by consultant and trainee surgeons using modern phacoemulsification techniques. Eight hospitals were able to obtain Caldicott Guardian (the person responsible for information governance) approval in time for the scheduled retrospective, anonymized data extraction from their EMR database in May 2015. This study was conducted in accordance with the Declaration of Helsinki, the United Kingdom Data Protection Act, and National Institute for Health Research guidance. A study period of 4 years (December 1, 2010–December 1, 2014) was selected to provide a large cohort with sufficient postoperative follow-up information and to capture the experience from the period when the vast majority of patients did not receive routine use of any prophylactic NSAIDs therapy for PME. In the United Kingdom during this period, topical NSAIDs were used routinely only for eyes at high risk of macular edema, so inclusion was likely to result in a strong bias. The number of eyes receiving them (698 after filtering) also was too small to result in meaningful analysis, so any eyes receiving such prophylaxis were excluded from analysis.

After extraction from each site, the datasets were pooled to a centralized database for analysis. All patients who were recorded on the database to have had any phacoemulsification and intraocular lens implantation procedure were analyzed. Those patients who underwent sequential surgery in the second eye during the study period had both eyes included, and data on individual eyes were treated as independent units for the purpose of this analysis. Data fields extracted on all eyes included: gender, laterality, pupil size, surgeon experience, preoperative and postoperative visual acuity, presence or absence of operative complications, diabetic status, ETDRS retinopathy and maculopathy status, the presence of macular copathologic features, and also other confounding

copathologic features such as glaucoma, corneal pathologic features, inherited macular disease, and no fundal view.

The standard of care for routine cataract surgery in the United Kingdom National Health Service is for all patients to have a nurse-led preoperative assessment (with multiple data items including diabetic status as compulsory yes-or-no questions recorded in the EMR), biometry, and examination by an ophthalmologist before surgery. The sites in this study routinely provide a tapering postoperative course of topical steroid and antibiotic drops for 4 weeks. All offer a single postoperative visit 4 to 6 weeks after surgery, usually conducted by a specialist nurse, hospital optometrist, or occasionally community optometrist. Eyes identified as being at risk of postoperative complications typically are followed up earlier by ophthalmologists, and those with DR are usually followed up in specialist retina clinics. It is not routine practice to perform OCT or fluorescein angiography after surgery unless the visual acuity outcome is not as expected. Our incidence figures therefore are likely to reflect visually significant macular edema, rather than subclinical disease only detectable using these investigations.

The presence of postoperative macular edema was defined as a recorded clinical finding or diagnosis of cystoid macular edema or for eyes from patients with diabetes, a newly recorded diagnosis of cystoid macular edema or clinically significant macular edema (having documented absence of preoperative maculopathy) within 90 days of surgery. These are both referred to under the broad term of *pseudophakic macular edema*. Optical coherence tomography and fluorescein angiography interpretation are not recorded consistently in the EMR system, which prevented analysis of these investigations, but it is unlikely that a diagnosis of PME would be made without at least one of these investigations having been performed.

Visual acuity was defined as the best value of uncorrected or corrected distance visual acuity available at each time point. The preoperative measurement used was that closest to the date of cataract surgery and recorded no more than 3 months before surgery. Visual acuity values were measured as either Snellen fractions or logarithm of the minimum angle of resolution units. Snellen fractions were converted to logarithm of the minimum angle of resolution units for analysis during the data extraction. Visual acuity values corresponding to counting fingers, hand movements, light perception, and no light perception were substituted for 2.10, 2.40, 2.70, and 3.00 logarithm of the minimum angle of resolution units, respectively, consistent with previous publications using this EMR system's data.<sup>9</sup>

From this cohort of patients, data from all eyes were refined progressively using sequential filters so that subgroups were created based on the presence of a single mutually exclusive criterion. To create distinct groups of eyes for comparison, the sequential filters were: (1) prior use of topical NSAIDs, (2) diabetic status, (3) presence of copathologic features, (4) intraoperative complications, (5) additional simultaneous surgical procedures, and (6) retinopathy or maculopathy status not recorded. The 3 main groups remaining were: group 1, eyes with no diabetes, no operative complications, and no copathologic features; group 2, eyes with no diabetes but with at least one copathologic feature or complication; and group 3, eyes with diabetes but no intraoperative complications and no copathologic features. Eyes were excluded from analysis if they had prior NSAID use (698 eyes across the 3 groups), confounding pathologic features, or no recording of diabetes or retinopathy status before and after surgery.

The incidence of PME was compared between the 3 groups, using group 1 as the reference cohort. The impact of certain risk factors on the risk of postoperative edema was analyzed for nondiabetic eyes (group 2). The impact of grade of retinopathy on the risk of PME was analyzed for patients with diabetes for eyes with and without retinopathy (group 3). Finally, the impact on

morbidity was evaluated by comparing eyes with and without PME in group 1 in terms of visual acuity and any adverse events of elevated intraocular pressure (IOP) after surgery. Multiple *t* tests using the Holm-Sidak method for multiple comparisons or chi-square tests with Yates correction were used as indicated in figure legends using GraphPad Prism software version 6.00 (GraphPad Software, La Jolla, CA). Relative risk (RR) calculations were performed according to Altman relative to the reference cohort and are shown using Forrest plots.<sup>11</sup>

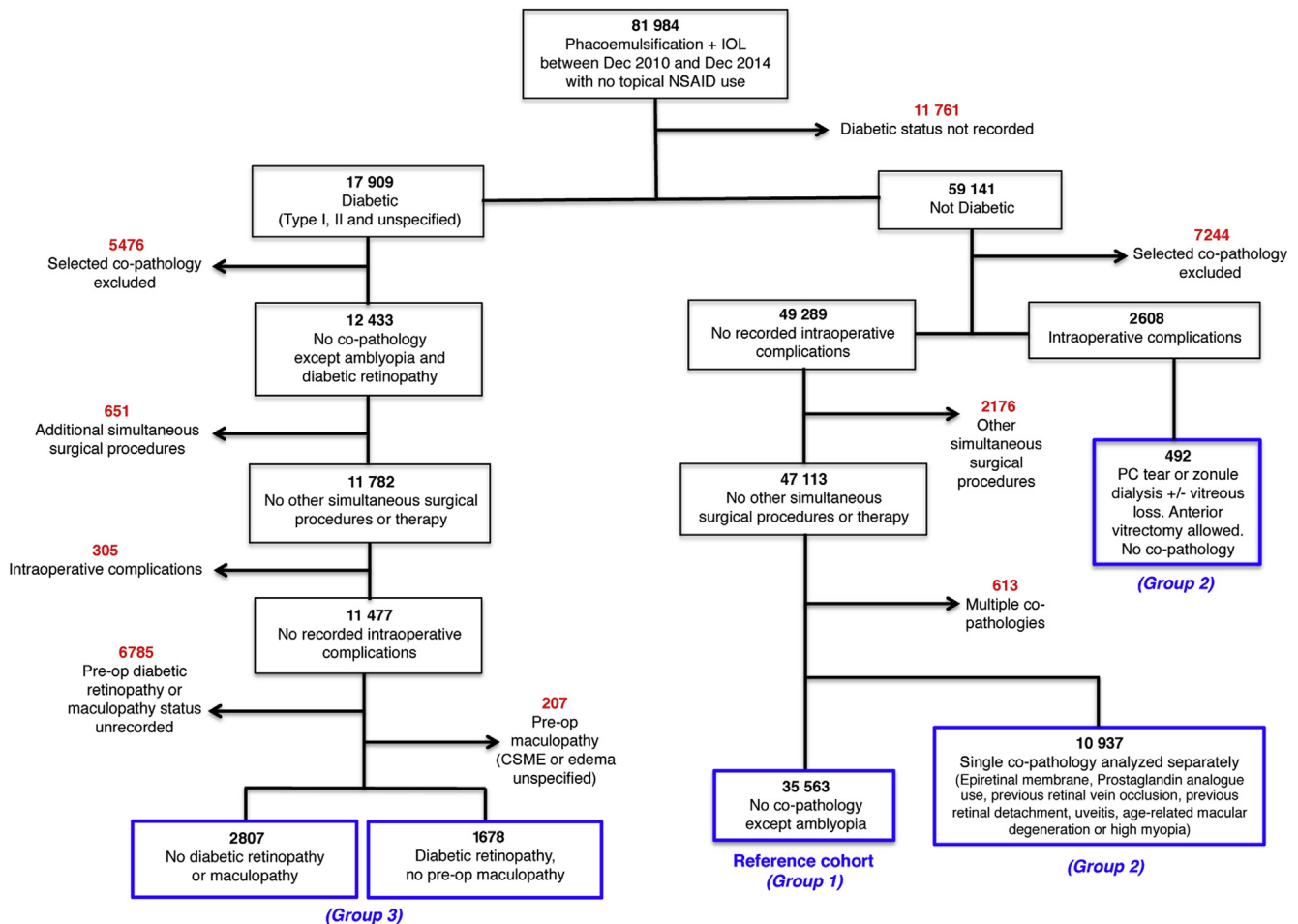
## Results

An initial dataset was collected on a total of 81 984 eyes, of which 17 909 were from patients with a diagnosis of diabetes at the time of surgery. The distribution of eyes after the process of filtering into the 3 analysis groups is shown in Figure 1.

Group 1 (no risk factors and no diagnosis of diabetes at the time of surgery) included 35 563 eyes, and the primary outcome of PME

was diagnosed in 415 eyes. This gave an incidence of 1.17%. The mean interval between surgery and first recording of PME was 39.5 days. Group 1 was designated as the reference cohort, and the incidences in the other 2 groups were compared with it. Within this group, a comparison of the proportions of eyes with and without certain preselected risk factors, such as laterality, pupil size, and surgeon experience, did not reveal an effect on the development of PME, but male gender had a significant influence ( $P = 0.0019$ ; Table 1). The morbidity from PME in terms of the impact on vision and elevated IOP is shown in Table 2 and Figure 2. Visual acuity was reduced significantly up to the latest time point, assessed up to 24 weeks ( $P < 0.0001$ ), and IOP was elevated significantly ( $P = 0.02$ ) up to 3 months after surgery.

Group 2 (eyes with at least a single risk factor and no diagnosis of diabetes at the time of surgery) included 11 429 eyes, and PME was diagnosed in 178 eyes, giving an overall incidence of 1.56%. This was significantly higher than in group 1 ( $P = 0.0013$ , chi-square test). Within this group, an analysis of the RR of PME developing for each preselected risk factor was compared with the



**Figure 1.** Flowchart showing study design and filtering strategy. Bold numbers indicate eyes in each group. Numbers in red show excluded eyes at each stage. Blue boxes indicate the eyes included in final analysis. The reference cohort (group 1) used to calculate the baseline incidence of postoperative pseudophakic macular edema (PME) and relative risk is indicated. “Copathology” refers to a group of nominal selections in the electronic medical record (EMR) system as summarized in “Methods” (e.g. glaucoma, corneal pathologic features, inherited retinal diseases, no fundal view). “Simultaneous surgical procedures” refers to any operation not phacoemulsification plus intraocular lens (IOL) implantation alone (e.g., pars plana vitrectomy, corneal graft, trabeculectomy, or intravitreal or periocular injection of substance). The cohort with a single risk factor of having a copathologic feature, including posterior capsule rupture, vitreous loss (group 2), or both, and eyes from patients with diabetes (group 3) are indicated. CSME = clinically significant macular edema; logMAR = logarithm of the minimum angle of resolution; NSAID = nonsteroidal anti-inflammatory drug; PC = posterior capsule.

Table 1. Nominal Data Characteristics of the Baseline Reference Cohort (Group 1) Comparing Eyes with Pseudophakic Macular Edema after Surgery with Those without Pseudophakic Macular Edema

	No Pseudophakic Macular Edema (No. of Eyes)	Pseudophakic Macular Edema (No. of Eyes)	Incidence (%)	P Value
Gender				
Male	13 679	193	1.391	0.0019
Female	21 469	222	1.023	
Eye				
Left	17 377	210	1.194	0.637
Right	17 770	205	1.140	
Pupil size				
Small	737	11	1.471	0.538
Large	29 408	344	1.156	
Surgeon experience				
Junior surgeon (resident)	2459	33	1.265	0.514
Senior surgeon (consultant)	17 792	197	1.107	

Male gender was associated with an increased incidence of postoperative pseudophakic macular edema. Small pupils or surgeons in the early years of training did not show a higher risk of postoperative pseudophakic macular edema. *P* values are shown for chi-square tests with Yates' correction.

reference level of 1.17%. This showed a significantly increased risk associated with the presence of epiretinal membrane (RR, 5.60; 95% CI, 3.45–9.07), previous retinal vein occlusion (RR, 4.47; 95% CI, 2.56–7.82), uveitis (RR, 2.88; 95% CI, 1.50–5.51), previous retinal detachment repair (RR, 3.93; 95% CI, 2.60–5.92), and the occurrence of posterior capsule rupture (RR, 2.61; 95% CI, 1.57–4.34). The other 3 preselected potential risk factors, namely preoperative prostaglandin use (RR, 1.11; 95% CI, 0.82–1.51), high myopia (RR, 0.82; 95% CI, 0.56–1.19), and dry age-related macular degeneration (RR, 0.80; 95% CI, 0.55–1.14) were not associated with a higher risk of PME (Fig 3).

Group 3 (eyes of patients who had a diagnosis of diabetes at the time of surgery and had a structured assessment of DR based on

mandatory recording of the presence or absence of signs of DR and maculopathy to generate a precise ETDRS grading) included 4485 eyes, and PME was diagnosed after surgery in 181 eyes, giving an incidence of 4.04%. This was significantly higher than either group 1 or 2 ( $P < 0.001$ , chi-square test). Within group 3, the RR of new macular edema developing after surgery compared with the reference level of 1.17% was higher significantly for patients with all retinopathy grades, including those with a documented absence of retinopathy (RR, 1.80; 95% CI, 1.38–2.36;  $n = 2748$ ) or those with the presence of any DR (RR, 6.23; 95% CI, 5.12–7.58;  $n = 1678$ ). Furthermore, the risk profile increased in a near linear trend proportional to the severity of the retinopathy (Fig 4). Eyes in group 3 that developed PME had significantly worse VA up to the latest time point assessed, up to 24 weeks ( $P < 0.002$ ). By way of comparison, the RR of PME in the 6785 eyes of patients with diabetes who did not have a structured assessment, and hence were excluded from detailed analysis as part of group 3, was 1.65. The presence of panretinal photocoagulation scars or inactive proliferative disease did not lead to a reduction in RR.

## Discussion

This is one of the largest studies of PME in routine real-world clinical practice, based on structured data extraction from 81 984 consecutive phacoemulsification cataract operations performed at 8 sites over 4 years that used the same EMR system. We believe this is the first study to isolate each risk factor sequentially to quantify the RR from each. Among eyes of patients who had diabetes, we were also able to analyze subsets of eyes that did not have any intraoperative complications, other known risk factors, or any preoperative macular edema and to stratify these eyes according to the severity of preoperative retinopathy. We found the mean incidence of postoperative edema to be 1.17% in eyes of patients who did not have diabetes at the time of surgery, but found a 4-fold increase in eyes of patients with diabetes.

These figures are similar to incidence rates of between 0.1% and 2.35% reported independently by Packer et al<sup>12</sup> and Henderson et al<sup>7</sup> in recent smaller retrospective

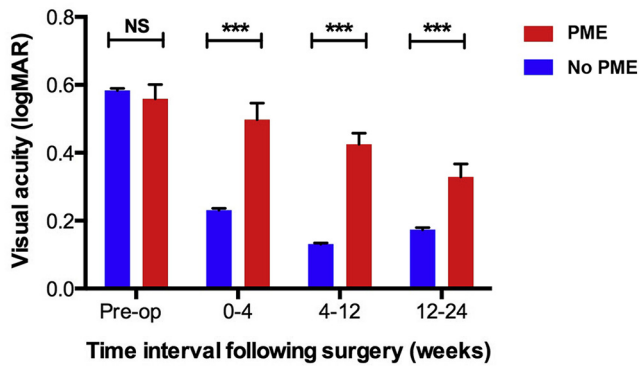
Table 2. Continuous Data Characteristics of the Baseline Reference Cohort (Group 1) Comparing Eyes with Pseudophakic Macular Edema after Surgery with Those without Pseudophakic Macular Edema

	No Pseudophakic Macular Edema			Pseudophakic Macular Edema			P Value
	Mean	Standard Deviation	No. of Eyes	Mean	Standard Deviation	No. of Eyes	
Age (yrs)	74.42	10.42	35 146	76.33	9.53	414	0.0002
Preoperative VA (logMAR)	0.590	0.495	35 109	0.567	0.567	415	0.3476
Postoperative VA (logMAR)							
Within 4 wks	0.224	0.285	15 251	0.496	0.362	241	<0.0001
4–12 wks	0.140	0.243	18 738	0.422	0.308	371	<0.0001
12–24 wks	0.178	0.252	9259	0.328	0.281	236	<0.0001
Axial length (mm)	23.40	1.183	35 137	23.35	1.164	415	0.3919
IOP (mmHg)							
Before surgery	16.15	3.175	26 780	16.43	3.285	343	0.1048
First within 3 months after surgery	14.90	3.374	21 479	15.31	3.264	371	0.0202

IOP = intraocular pressure; logMAR = logarithm of the minimum angle of resolution; VA = visual acuity.

Statistically significant findings included older age in the cystoid macular edema group, with a relatively lower VA at all time points studied. Intraocular pressure decreased after surgery as expected, but was higher in the pseudophakic macular edema group. *P* values were generated by multiple *t* tests using the Holm-Sidak method for multiple comparisons using an  $\alpha$  of 5.00.





**Figure 2.** Bar graph showing visual acuity (in logarithm of the minimum angle of resolution [logMAR] units) after cataract extraction in the baseline reference cohort (group 1) comparing eyes in which pseudophakic macular edema (PME) developed after surgery with those without PME. Plotted for data in Table 1. Mean value  $\pm$  95% confidence interval shown. *P* values were generated by the multiple *t* test with the Holm-Sidak method for multiple comparisons using an  $\alpha$  of 5.00. \*\*\**P* < 0.0001. NS = not significant.

studies. Within our reference cohort of eyes without any identified risk factors, the incidence of PME was higher in older patients, as previously identified.<sup>7,13</sup> The increased incidence attributable to male gender is a finding not demonstrated before in other studies. It is unclear why men are at higher risk, but it is unlikely to be a confounding factor resulting from age because they were on average younger than the female patients included in the study.

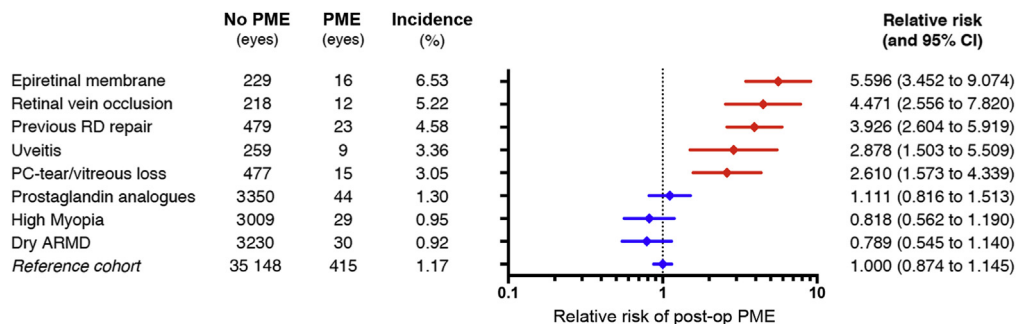
Our finding that patients who were not diabetic, but possessed a known risk factor, had a higher risk of PME has been reported in other studies and has been emphasized in comprehensive reviews of the published literature.<sup>7,14,15</sup> However, this is the first study to isolate each risk factor with rigorous exclusion criteria and large enough numbers to confirm or exclude statistically significant changes in RR. Among patients who had diabetes, we were able to analyze subsets of eyes that did not have any intraoperative complications, other known risk factors, or any preoperative macular edema and to stratify these eyes according to the severity of preoperative retinopathy. We found not only an

overall increased risk of PME that we attribute to the presence of diabetes, but also a near linear increase in risk dependent on the ETDRS-graded severity of retinopathy. This finding is consistent with the intuitive expectation of deficient blood-retinal barrier function in those patients with more advanced vascular changes resulting from DR. Although the higher risk of PME in patients with diabetes and retinopathy has been documented,<sup>16,17</sup> we believe this is the first study to quantify the ascending risk of PME with increasing severity of retinopathy using data captured from a comprehensive and structured ETDRS grading system.

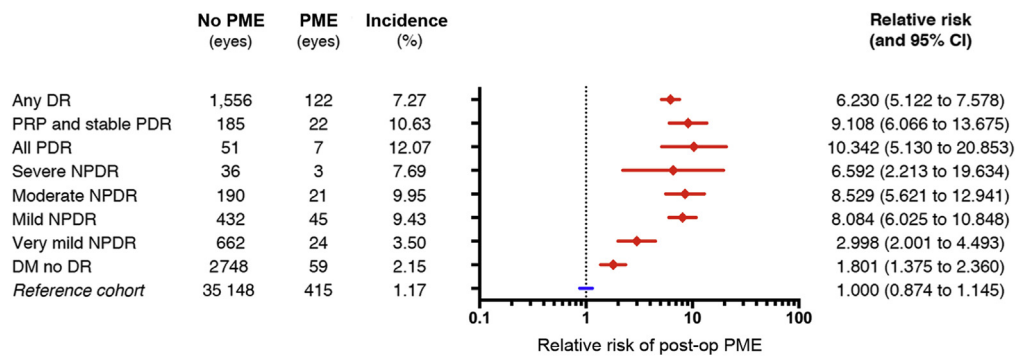
Many previous studies of PME have excluded patients with diabetes,<sup>7,8</sup> had insufficient numbers, or lacked precise ETDRS grading of DR before and after surgery; however, it is recognized that the risk of PME is higher in patients with diabetes.<sup>15</sup> This study used the largest published cohort of patients with diabetes (4485 eyes) undergoing cataract surgery with precisely defined preoperative and postoperative ETDRS grading of DR. Only eyes with grading and a confirmed absence of macular edema before surgery were analyzed. This criterion resulted in exclusion of more than 6992 eyes lacking such information, but nevertheless is still the largest published dataset. Even eyes with no retinopathy have an increased RR of PME of 1.80 compared with the reference cohort, which increases substantially to a maximum RR of 10.34 with escalating severity of the DR grade. The risk of PME did not resolve when the presence of panretinal photocoagulation had been noted.

The condition we found to carry the highest risk for development of PME in patients who did not have diabetes was the presence of epiretinal membrane before surgery (RR, 5.60). Although this is in keeping with previously published data,<sup>7,18</sup> we suspect that there could have been a considerable amount of underreporting of preoperative epiretinal membrane in our real-world cohort, because it is unusual to examine the macula with OCT before routine cataract surgery at our study sites. The high RR of PME in this group therefore may reflect only eyes with clinically obvious epiretinal membrane before surgery.

With regard to other risk factors, our results were not completely congruous with those previously reported. For instance, our data showed that intraoperative capsule rupture



**Figure 3.** Graph showing the relative risk for eyes from patients without diabetes with a single copathologic feature or risk factor (group 2). The mean relative risk compared with the reference cohort is plotted with 95% confidence intervals (CIs). Because only a single risk factor was permitted, each diagnosis was mutually exclusive, so eyes were analyzed only once (Fig 1, group 2). Groups reaching a statistically significant value of at least *P* < 0.05 are marked in red on the graph. ARMD = age-related macular degeneration; PC = posterior capsule; PME = pseudophakic macular edema; RD = retinal detachment.



**Figure 4.** Graph showing the relative risk of new macular edema according to diabetic retinopathy (DR) grade for eyes of patients with diabetes (group 3). Only eyes with the recorded absence of preoperative maculopathy were included (Fig 1, group 3). The mean relative risk compared with the reference cohort is plotted with 95% confidence intervals (CIs). Groups reaching a statistically significant value of at least  $P < 0.05$  are marked in red on the graph. DM = diabetes mellitus; DR = diabetic retinopathy; NPDR = nonproliferative diabetic retinopathy; PDR = proliferative diabetic retinopathy; PME = pseudophakic macular edema; PRP = panretinal photocoagulation.

was associated with a higher risk of PME as commonly accepted, but this factor has not been shown to be significant in other smaller studies, although it is possible they lacked sufficient power to identify the association.<sup>7</sup> Conversely, although there have been small case series suggesting a causal relationship between topical prostaglandin analogs and PME, our larger study of 3394 eyes showed no significant increase in risk.<sup>19,20</sup> This difference may be the result of the effect of case selection in other studies and the larger sample size in our study. Other studies did not systematically isolate each risk factor for PME with some cases possessing 1 or more suspected independent risk factors such as posterior capsular rupture or uveitis.

Pseudophakic macular edema commonly is thought to be a self-limiting condition with low visual morbidity, and surprisingly few studies have been published that compare the visual morbidity in eyes with and without PME.<sup>5,15</sup> In a study with variable follow-up, Henderson et al<sup>7</sup> found significantly poorer visual acuity in those with PME at the final follow-up visit, and a meta-analysis of studies evaluating topical steroids and topical nonsteroidal agents for PME also found reduced final visual acuity in eyes with PME.<sup>3</sup> In our study, we compared 415 eyes with PME with 35 146 eyes with no PME. We found a highly significant difference between these groups of eyes in terms of visual acuity up to the last extracted follow-up data at 24 weeks after surgery. In addition, there was a significant difference in IOP between these groups of eyes, which we attributed to the effect of additional postoperative corticosteroid therapy in eyes with PME. These clinical outcomes data help to highlight the potential seriousness of PME and complements the evidence on the public health burden published by Schmier et al<sup>13</sup> showing that the cost of cases with PME was 41% higher (\$3298) compared with controls.

The incidence rates of PME estimated by our study method were based on a survey of consecutive eyes rather than of patients. Although this method may not be valid for extrapolation to derive the true incidence rate for a population, it should give an accurate estimation of the burden of PME in a certain volume of cataract operations, and as such

may be a more useful statistic in the real-world setting. In this study, which captured management in clinical practice retrospectively from EMR entries, we could not exclude that patients were managed for postoperative complications in the emergency departments of included sites where EMR systems were not always used routinely. However, we believe that this error may be quite small because of the long postoperative period over which the data extraction was undertaken, because it would have been unusual for many cases of PME to be managed in the emergency room for up to 90 days after surgery. Additionally, we suspect that not all patients with reduced vision after surgery underwent OCT or angiography and that mild cases of PME may have been missed. Both factors could have led to underreporting of cases, but we believe this limitation would not change the significance of the RR of each factor identified, because any bias should be systematic across all groups. Therefore, the RR of each factor estimated from this study should be valid and may be a better basis for deciding protocols of escalating intensity of prophylaxis for each risk factor, rather than the absolute incidence of PME.

A distinct strength of this study is its pragmatic nature with extraction of highly structured data conforming to nationally agreed datasets from EMR systems.<sup>9,10</sup> This allowed detailed analysis of the influence of a wide range of preoperative and operative risk factors for PME, and in particular the precise influence of preoperative ETDRS grade of DR.

In summary, this large study confirms the significance of PME as one of the most common causes of reduced vision after cataract surgery. Uniquely, it defines and quantifies the key risk factors for PME using standardized data captured within a uniform EMR platform during routine clinical practice in a very large cohort of eyes. These findings will allow clinicians to counsel patients more accurately on the risk and consequence of PME when undergoing cataract surgery and will be valuable for assigning the resources needed to better manage PME, particularly as newer prophylactic agents such as NSAIDs are translated into routine clinical practice.<sup>21–23</sup>

## References

- Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. *Br J Ophthalmol* 2012;96:614–8.
- Kim SJ, Schoenberger SD, Thorne JE, et al. Topical nonsteroidal anti-inflammatory drugs and cataract surgery: a report by the American Academy of Ophthalmology. *Ophthalmology* 2015;122:2159–68.
- Kessel L, Tendal B, Jørgensen KJ, et al. Post-cataract prevention of inflammation and macular edema by steroid and nonsteroidal anti-inflammatory eye drops: a systematic review. *Ophthalmology* 2014;121:1915–24.
- Flach AJ. The incidence, pathogenesis and treatment of cystoid macular edema following cataract surgery. *Trans Am Ophthalmol Soc* 1998;96:557–634.
- Yonekawa Y, Kim IK. Pseudophakic cystoid macular edema. *Curr Opin Ophthalmol* 2012;23:26–32.
- Lobo C. Pseudophakic cystoid macular edema. *Ophthalmologica* 2012;227:61–7.
- Henderson BA, Kim JY, Ament CS, et al. Clinical pseudophakic cystoid macular edema. *J Cataract Refract Surg* 2007;33:1550–8.
- Gulkilik G, Kocabora S, Taskapili M, Engin G. Cystoid macular edema after phacoemulsification: risk factors and effect on visual acuity. *Can J Ophthalmol* 2006;41:699–703.
- Day AC, Donachie PHJ, Sparrow JM, et al. The Royal College of Ophthalmologists' National Ophthalmology Database study of cataract surgery: report 1, visual outcomes and complications. *Eye* 2015;29:552–60.
- Keenan TDL, Johnston RL, Donachie PHJ, et al. United Kingdom National Ophthalmology Database Study: Diabetic Retinopathy. Report 1: prevalence of centre-involving diabetic macular oedema and other grades of maculopathy and retinopathy in hospital eye services. *Eye* 2013;27:1397–404.
- Altman DG. Confidence intervals for the number needed to treat. *BMJ* 1998;17:1309–12.
- Packer M, Lowe J, Fine H. Incidence of acute postoperative cystoid macular edema in clinical practice. *J Cataract Refract Surg* 2012;38:2108–11.
- Schmier JK, Halpern MT, Covert DW, Matthews GP. Evaluation of costs for cystoid macular edema among patients after cataract surgery. *Retina* 2007;27:621–8.
- Bélair M-L, Kim SJ, Thorne JE, et al. Incidence of cystoid macular edema after cataract surgery in patients with and without uveitis using optical coherence tomography. *Am J Ophthalmol* 2009;148:128–135.e2.
- Loewenstein A, Zur D. Postsurgical cystoid macular edema. *Dev Ophthalmol* 2010;47:148–59.
- Brito PN, Rosas VM, Coentrão LM, et al. Evaluation of visual acuity, macular status, and subfoveal choroidal thickness changes after cataract surgery in eyes with diabetic retinopathy. *Retina* 2015;35:294–302.
- Horozoglu F, Yanyali A, Aytug B, et al. Macular thickness changes after phacoemulsification in previously vitrectomized eyes for diabetic macular edema. *Retina* 2011;31:1095–100.
- Frisina R, Pinackatt SJ, Sartore M, et al. Cystoid macular edema after pars plana vitrectomy for idiopathic epiretinal membrane. *Graefes Arch Clin Exp Ophthalmol* 2015;253:47–56.
- Moroi SE, Gottfredsdottir MS, Scheingart MT, et al. Cystoid macular edema associated with latanoprost therapy in a case series of patients with glaucoma and ocular hypertension. *Ophthalmology* 1999;106:1024–9.
- Warwar RE, Bullock JD, Ballal D. Cystoid macular edema and anterior uveitis associated with latanoprost use. Experience and incidence in a retrospective review of 94 patients. *Ophthalmology* 1998;105:263–8.
- Singh R, Alpern L, Jaffe GJ, et al. Evaluation of nepafenac in prevention of macular edema following cataract surgery in patients with diabetic retinopathy. *Clin Ophthalmol* 2012;6:1259–69.
- Mathys KC, Cohen KL. Impact of nepafenac 0.1% on macular thickness and postoperative visual acuity after cataract surgery in patients at low risk for cystoid macular oedema. *Eye* 2010;24:90–6.
- Wolf EJ, Braunstein A, Shih C, Braunstein RE. Incidence of visually significant pseudophakic macular edema after uneventful phacoemulsification in patients treated with nepafenac. *J Cataract Refract Surg* 2007;33:1546–9.

## Footnotes and Financial Disclosures

Originally received: August 10, 2015.

Final revision: September 22, 2015.

Accepted: October 1, 2015.

Available online: December 8, 2015. Manuscript no. 2015-1344.

<sup>1</sup> School of Clinical Sciences, University of Bristol and Bristol Eye Hospital, Bristol, United Kingdom.

<sup>2</sup> Gloucestershire Eye Unit, Cheltenham General Hospital, Sandford Road, Cheltenham, United Kingdom.

<sup>3</sup> Jones Eye Institute, University of Arkansas for Medical Sciences, Little Rock, Arkansas.

<sup>4</sup> Wolverhampton Eye Infirmary, Royal Wolverhampton Hospitals NHS Trust, New Cross, Wolverhampton, United Kingdom.

<sup>5</sup> Sandwell and West Birmingham NHS Trust, Birmingham, United Kingdom.

\*The full details of contributors to the UK Pseudophakic Macular Edema Study Group are listed online in the Appendix.

Financial Disclosure(s):

The author(s) have no proprietary or commercial interest in any materials discussed in this article.

Supported by the National Institute for Health Research (academic clinical lecturer support to C.J.C.). Alcon (Fort Worth, TX) provided financial support with a research grant to cover the cost of data extraction and open access but did not play any role in the design or conduct of the study and did not have any input into the preparation and content of the manuscript. Robert Johnston is the Medical Director of Medisoft Limited, the EMR supplier to each contributing site and Medisoft was funded to perform the data extraction.

Author Contributions:

Conception and design: Johnston, Chu, Sallam, Mohamed, Yang

Analysis and interpretation: Johnston, Chu, Yang

Data collection: Johnston, Chu, Buscombe, Yang

Obtained funding: none

Overall responsibility: Johnston, Chu, Buscombe, Sallam, Mohamed, Yang

Abbreviations and Acronyms:

**CI** = confidence interval; **CSME** = clinically significant macular edema; **DR** = diabetic retinopathy; **EMR** = electronic medical record; **ETDRS** = Early Treatment Diabetic Retinopathy Study; **IOP** = intraocular pressure;



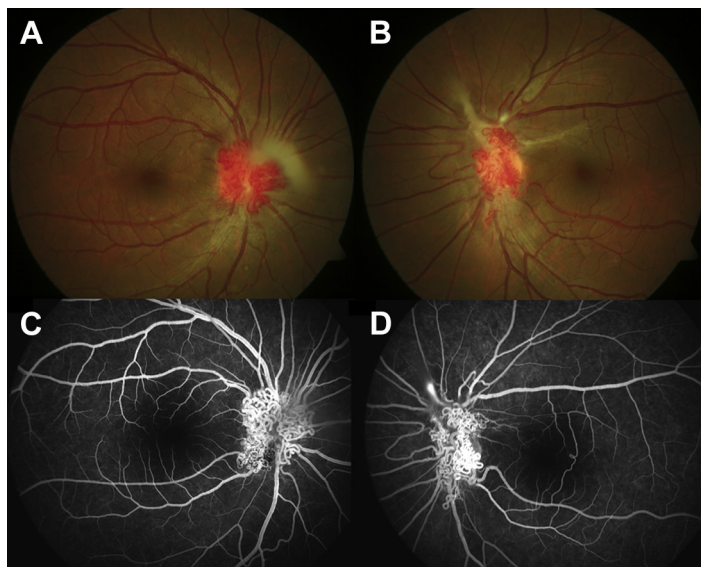
**NPDR** = nonproliferative diabetic retinopathy; **NSAID** = nonsteroidal anti-inflammatory drug; **OCT** = optical coherence tomography; **PDR** = proliferative diabetic retinopathy; **PME** = pseudophakic macular edema; **RR** = relative risk; **VA** = visual acuity.

Correspondence:

Robert L. Johnston, FRCOphth, Gloucestershire Eye Unit, Cheltenham General Hospital, Sandford Road, Cheltenham GL53 7AN, United Kingdom. E-mail: [Rob.Johnston@glos.nhs.uk](mailto:Rob.Johnston@glos.nhs.uk).

## Pictures & Perspectives

---



### Bilateral Peripapillary Racemose Hemangioma: An Unusual Presentation

A 17-year-old boy presented with a 10-day history of transient vision loss in the right eye. (A) Right fundus examination revealed dilated and tortuous epipapillary retinal vessels with adjacent epiretinal fibrosis. (B) Left fundus examination revealed dilated and tortuous epipapillary, peripapillary retinal vessels with adjacent epiretinal fibrosis, and indirect arterio-venous communication in the perifoveal area. (C, D) Fluorescein angiograms of both eyes showed arteriovenous anastomosis of epipapillary retinal vessels and rapid filling of vessels with no associated leakage. Based on the clinical findings, the diagnosis of bilateral peripapillary and epipapillary racemose hemangioma was made.

SWATHI KALIKI, MD<sup>1</sup>

MUDIT TYAGI, MD<sup>2</sup>

HARI P. KUMAR, BSOPT<sup>2</sup>

<sup>1</sup>The Operation Eyesight Universal Institute for Eye Cancer, Hyderabad, India; <sup>2</sup>Retina and Uvea Services, L V Prasad Eye Institute, Hyderabad, India

### Footnotes and Financial Disclosures

---

Support provided by The Operation Eyesight Universal Institute for Eye Cancer (S.K.) and Hyderabad Eye Research Foundation (S.K.), Hyderabad, India. No conflicting relationship exists for any author.

---